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SENIOR HIGH SCHOOL CURRICULUM GUIDE FOR SCIENCE

Department of Education
September, 1970

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SENIOR HIGH SCHOOL CURRICULUM GUIDE FOR SCIENCE

Department of Education
Edmonton, Alberta
September, 1970

ACKNOWLEDGEMENT

The Department of Education acknowledges with appreciation the contributions of the members of the Secondary School Science Committee to this Curriculum Guide for Senior High School Physical Science. The committee has operated under the guidance of the Secondary School Curriculum Board.

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NOTE: This curriculum guide is a service publication only. The information is prescriptive only insofar as the content of the curriculum guide duplicates that contained in the Senior High School Program of Studies. The curriculum guide contains as well as content, however, methods of developing the concepts, suggestions for the use of teaching aids and lists of additional reference books.

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OBJECTIVES FOR COURSES IN SCIENCE

Students should:

1. Acquire facts, principles, and concepts in order to understand and interpret their environment.
2. Acquire some competence in critical thinking, and appreciation of scientific inquiry.
3. Develop a scientific attitude.
4. Develop scientific literacy.

GENERAL OBSERVATIONS CONCERNING THE TEACHING OF SCIENCE

1. Experimental work is to be considered an integral part of each course.
2. All lessons should stress and illustrate scientific inquiry. Conclusions should be based on actual observations wherever possible.
3. In demonstrations and student experimental work emphasis should be on the scientific principles.
4. Teaching aids (films, pictures, models, etc.) should be used freely. See the reference list at the end of the guide.
5. Constant review, such as the short test, is valuable. New concepts should be related, where possible, to previous work covered.
6. The vocabulary of science should be emphasized.
7. Safety should be stressed at all times (see below).

SAFETY AND MAINTENANCE OF THE SCIENCE LABORATORY

1. Teachers should become aware of potentially dangerous experiments and demonstrations planned in their program and take adequate steps to prevent an accident.
2. Students should be made aware of potentially dangerous activities in doing experiments, and should understand and be made to follow directions.
3. Chemicals should be stored in a neat and orderly manner, and should be arranged *alphabetically.*
4. Care should be taken in storing chemicals, e.g., the kerosene level on sodium and the water level on phosphorus should be checked. Metallic equipment should not be stored near chemicals which may cause its corrosion.
5. All laboratory activities should be supervised. Students should be taught how to use and care for laboratory equipment. All equipment should be cleaned before being put away.
6. All apparatus should be in good repair. Irreparable equipment should be discarded. In particular, chipped glassware can be dangerous.
7. The science teacher should see that chemicals and equipment are ordered and available as required. A spring inventory or a continuing record of impending shortages will be helpful in making up order lists.
8. Safety equipment (fire extinguishers, asbestos blankets, eye washers, etc.) should be provided in each science laboratory and should be readily accessible. Students should be instructed in the proper use of this equipment.
9. Teachers and students should wear safety glasses and aprons or laboratory smocks during demonstrations and experiments where potentially dangerous chemicals are handled.
10. A first-aid kit should be available.

NOTES TO TEACHERS

1. The times indicated in the course outline are suggestive only, and include the time for experiment, review work and examinations.
2. Suggestions regarding time allotments for courses and the format of this guide are invited and should be forwarded to the Curriculum Branch.

CHEMISTRY 10

There is no alternative program for CHEMISTRY 10

TEXTS:

Chemistry, An Experimental Science (CHEM STUDY)

Laboratory Manual to accompany *Chemistry, An Experimental Science*

REFERENCES: A list of chemistry references is provided at the end of this guide.

COURSE OUTLINE:

Chapter Number	Chapter Title	Experiment Number(s)	Suggested Time In Periods	Comments
1	Chemistry: An Experimental Science	1, 2, 3, 4 and 5	10	See 3 (a, b, c) under NOTES TO TEACHERS
2	A Scientific Model: The Atomic Theory	6, 7	17	
3	Chemical Reactions	8	12	
4	The Gas Phase: Kinetic Theory	9	14	See 2 below
5	Liquids and Solids: Condensed Phases of Matter	10, 11	17	
6	Structure of the Atom and the Periodic Table		13	

NOTES TO TEACHERS

1. The following materials are available to teachers offering the CHEM STUDY program:
   (a) *Teacher's Guide for Chemistry, An Experimental Science* (available from the School Book Branch)
   (b) Programmed instruction pamphlets: "Slide Rule" and "Exponential Notation"
   (c) Achievement Tests: These are available as chapter, semester and final examinations. Batteries of these tests are published for 1963-64, 1964-65 and 1965-66.
   Items (b) and (c) are available from W. H. Freeman Company, 660 Market Street, San Francisco 94104.
   (d) Films:
   1. Gases and How They Combine (Chapter 3)
   2. Gas Pressures and Molecular Collisions (Chapter 4)
   3. Chemical Families (Chapter 5) are considered useful aids in teaching the chapters indicated.

   These films are available from the following sources:
   1. Audio/Visual Services Branch, Department of Education
   2. Department of Extension, University of Alberta, Edmonton
   3. Modern Learning Aids — 1975 Leslie Street, Don Mills, Ontario
2. (a) The first three chapters are introductory. Succeeding chapters expand on these introductory ideas.
   (b) Spend only sufficient time on "uncertainty" to enable students to become acquainted with mechanics of it (2 days). The programmed pamphlet "Exponential Notation" is useful.
   (c) Do not introduce use of significant figures until Chapter 4. The above program is also useful for developing this topic.
   (d) Beginning with Chapter 4 of this course it may be helpful to the slower students to provide them with supplementary problems from other texts before attempting questions in the CHEM study text.
3. Teachers should feel free to adapt and modify experiments from the standpoint of materials, equipment and reagents.

SUPPLIES LIST FOR CHEMISTRY 10

The quantities suggested in this list are based on the assumption that each student in a class of 30 can carry on individual experiments.

Equipment

1 absolute zero demonstrator

1 needle valve or regulator

Glass Equipment

3 beakers, 2 litre

30 beakers, 400 ml.

30 beakers, 250 ml.

30 beakers, 100 ml.

30 burettes, 50 ml.
or
gas measuring tubes

3 Erlenmeyer flasks, 250 ml.

30 pipettes, 1 ml. graduated

60 test tubes, 18 x 150 mm.

150 test tubes, 13 x 100 mm.

30 vial shell forms, 15 x 45 mm.

30 watch glasses, 75 mm. diameter

Hardware

5 burette brushes

30 burners

30 clamps, utility

15 funnel racks

15 meter rulers

30 pinch or screw clamps

30 ring stands, 18 in.

30 ring supports, 4 in.

60 feet rubber tubing, 1/4 or 3/16 in.

30 squeeze bottles, 250 ml.

30 stoppers, cork No. 3

30 stoppers, 1 hole, No. 0 or 00

30 stoppers, 1 hole, rubber No. 6

30 stoppers, 2 hole, No. 6

30 test tube brushes

30 test tube holders

30 test tube racks

30 thermometers, -10° to 110° C

15 water troughs, pneumatic

15 water reservoirs 6 in. deep

30 wire gauges, 5 x 5 in. asbestos centre

Chemicals

1 litre acetone or amyl alcohol

6 g. $AlCl_3.6H_2O$

14 g. $Al_2(SO_4)_3.18H_2O$

20 g. $BaCl_2.2H_2O$

10 g. $Ba(NO_3)_2$

150 ml. benzene

100 g. $Ca(OH)_2$

10 g. $CoCl_2.6H_2O$

10 g. $Co(NO_3)_2.6H_2O$

1 lb. copper wire, 16 gauge

300 g. paradichlorobenzene

500 ml. ethanol

10 g. $FeCl_3.6H_2O$

500 cm^2 lead sheet, 1/32" thick

120 g. $Pb(NO_3)_2$

150 ml. methanol

2 litres HNO_3, concentrated

oxygen, bottled

150 g. paraffin, household

5 g. KCl

10 g. K_2CrO_4

10 g. KOH

10 g. AgCl

150 g. $AgNO_3$

50 g. NaCl

5 g. Na_2CrO_4

50 g. NaOH

60 g. NaI

5 g. $NaNO_3$

10 g. Na_2SO_4, anhydrous

10 g. $Sr(NO_3)_2$

10 g. sugar

10 g. sulfur

2 litres H_2SO_4, concentrated

15 g. tin, sheet or mossy

Class Equipment

15 balances, centigram

2 balances, platform

1 barometer

1 conductivity apparatus

neon glow bulb

lamp, 10 watt

lamp, 40 watt

30 funnels, 75 mm. diameter

3 funnels, separatory

30 glass plates, 10 x 10 cm.

30 glass stirring rods, 6 mm.

30 glass tubing, 6 mm. 4 ft. long

30 graduates, 10 ml.

30 graduates, 25 ml.

30 graduates, 100 ml.

3 jars, 1/2 gal. or Winchesters

30 medicine droppers

Miscellaneous

1 roll aluminum foil

30 soup cans

30 large fruit cans

30 lids, 4 in.

30 candles, household

60 shts. filter paper, 11 cm. diameter

30 plastic bags, 1 quart

1/10 lb. steel wool, No. 00

PHYSICS 10

TEXT: (Alternative programs are available)

Fundamentals of Physics, Stollberg, Hill and Nygaard

REFERENCES: A list of physics references is provided at the end of this guide.

COURSE OUTLINE: ALTERNATIVE I

Chapter Number	Chapter Title	Investigation Numbers	Suggested Time In Periods	Comments
1	The Science of Physics	1	2	Quick treatment of chapter. Experiment should be done in small groups.
	Some mathematics basic to physics			This fundamental material should be covered before starting an orderly discussion of the remainder of the course.
	Scientific Notation		1	
	Significant Digits	2A	1	Appendix 1, Sect. 2-16 Appendix 2, Sect. 2-15, 2-17, 2-20
	Graphing Experimental Data		1	Appendix 3
	Percent Error		1	Appendix 4, Sect. 2-18, 2-19
	The Slide Rule	3	2	Steps 1 to 5 inclusive.
2	Motion & Measurement	2B, 5	8	Sect. 1 to 8 inclusive. Quantitative treatment of units which follow should include Sect. 2-9, 2-10 & Inv. 4*
3	Force & Motion	6	10	Sect. 3-1 to 3-7 and Sect. 3-16. For more quantitative treatment include Sect. 3-8, 3-9, 3-12, 3-13, 3-17, 3-18 and 3-20.
4	Work & Energy	4	1	Sect. 4-1 *and* 4-11 to 4-15 inclusive.
5	Force in Fluids	7	10	Sect. 5-1 to 5-8 incl. and Sect. 5-13 to 5-19
6	Molecules & Atoms in Motion	9, 10	10	Emphasize Sect. 6-14 and 6-19. Otherwise quick treatment.
7	Measurement of Temperature and Heat	12	13	Omit Sect. 7-12
8	Heat & Change of Physical State	13, 14	17	Sect. 8-16 and 8-17 are optional. Omit 8-15 to 8-22 incl.

NOTES TO TEACHERS:

1. (a) The textbooks for Physics 10 and 20 and Physics 30 were obtained by dividing and adapting the textbook *Physics, Fundamentals and Frontiers* into *Fundamentals of Physics* and *Frontiers of Physics* respectively.

   (b) A special Teacher's Edition is available for *Fundamentals of Physics.*

   (c) There is no Teacher's Edition of *Frontiers of Physics.* Therefore only the Teacher's Edition of *Physics, Fundamentals and Frontiers* is available for Physics 30. To facilitate the simultaneous use of both the *Frontiers of Physics* and the Teacher's Edition, *Physics, Fundamentals and Frontiers,* a list of cross references is available.

   (d) *Solution-Answer Key and Laboratory Guide* is available for *Fundamentals of Physics.*

   (e) There is no solution-answer key and laboratory guide available for *Frontiers of Physics.* Teachers of Physics 30 may use the *Solution-Answer Key and Laboratory Guide* for *Physics, Fundamentals and Frontiers.*

   (f) *Progress and Unit tests* to accompany *Physics, Fundamentals and Frontiers* and an answer key may be obtained directly from Thomas Nelson and Sons, 81 Curlew Drive, Don Mills, Ontario.

2. (a) The "Investigations" should be performed by student groups of two or three with all students working on the same investigation at the same time.

   (b) The section FOR FURTHER INVESTIGATION should be considered supplementary.

   (c) The teacher is not restricted to procedures and equipment described in the textbook investigations, but may use other experiments that demonstrate the same principles.

   (d) The laboratory section is designed to permit the teacher to use an investigative approach to teaching physics. In order to use it effectively for this purpose, it is imperative that the investigations be done at the right time. A summary of suggested placement of each "Investigation" in relation to the theory of the Physics 10 program is given below:

Investigation	Type*	When the Investigation Should Be Done
How a Scientist Learns (1)	D	Before discussing Section 1-1.
The Measurement of Length (2)	S	Part A, before discussing Appendix 2. Part B, after discussing Section 2-7.
Precision Measurement of Length (5)	S	Immediately after doing Investigation 2, Part B.
Accelerated Motion (4)	D	Before discussing Section 2-8.
Weight and Mass (6)	D	Before discussing Section 3-1.
Pressure in a Liquid (7)	D	Immediately after discussing Section 5-3 and before discussing Section 5-4.
Molecules (9)	P	Before discussing Section 6-1, but not obligatory.
Pressure and Volume of a Gas (10)	D	Before discussing Section 6-19.
Specific Heat Capacity of a Metal (12)	S, P	After discussing Section 7-20.
The Melting Temperature of a Pure Substance (Chem Study Laboratory Manual: Experiment 3)	D	Before discussing Section 8-1.
The Melting of Ice (13)	D	Before discussing Section 8-1.
Temperature and Volume of a Gas (14)	D	Before discussing Section 8-13.

*D—discovery; P—application of principles; S—skill.

For further information, see section entitled INTRODUCTION TO THE TEACHER in the *Solution-Answer Key and Laboratory Guide.*

SUPPLIES LIST FOR PHYSICS 10

The quantities of supplies shown are for a group of two or three students. These supplies are listed according to INVESTIGATIONS.

CAUTION: In some cases there will be repetitions of equipment.

INVESTIGATION 1—How a Scientist Learns

1 block of wood, 2 in. x 4 in. x 6 in.

1 small wheeled cart with low friction wheels and with flat surface for sliding when upside down. A PSSC 3-wheeled dynamics cart or Hall's car may be used.

1 metal ball weighing at least 200 gf. with hook

1 support rod, 36 in. (approximately), with support base

1 suspension clamp

1 ball weighing more than the cart, without hook

string

1 C clamp

1 meter stick

1 set of weights

INVESTIGATION 2—The Measurement Of Length

1 meter stick (centimeters on one side and inches on the other)

1 block of wood

INVESTIGATION 3—The Slide Rule

1 slide rule per student

1 demonstration slide rule

INVESTIGATION 4—Accelerated Motion

1 recording timer kit

1 PSSC 3-wheeled dynamics cart or Hall's car

1 rod-type pulley

1 set of hooked weights

1 dry cell battery, 1.5 volt or low voltage power supply

1 meter stick

1 table clamp for holding rod-type pulleys

1 clothes pin

1 C clamp

string

INVESTIGATION 5—Precision Measurement of Length

1 vernier caliper (metric)

1 micrometer caliper (metric)

Miscellaneous objects such as:
window glass, glass tubing, marbles, sheets of paper, wire, human hair, pencils, coins

INVESTIGATION 6—Weight and Mass

4 large tin cans with wire handles (48 oz. fruit cans with one end removed and two holes punched on each side near the open end)

2 support rods, 36 in. (approximately) with support base

2 C clamps

4 suspension clamps

3 sets of weights, slotted or hooked (or other suitable materials to load the cans)

string

gummed tape

scrap paper

INVESTIGATION 7—Pressure In a Liquid

1 tube, annealed ends, flint, 2.5 cm. in diameter and 30 cm. long (a large test tube, 38 x 300 mm., may be used if glass tubing of this diameter is not available)

1 hydrometer jar, 1,000 ml. graduated cylinder or ½ gal. sealer

1 meter stick

lead shot

2 sets of hooked weights or others having 10 gf. and 20 gf. weights that fit into the glass tubing

1 rubber stopper that fits into the tubing with its end flush with the end of the tubing (not required if the test tube is used)

1 laboratory balance

INVESTIGATION 9—Molecules

This investigation consists of 14 demonstrations. The quantity of equipment indicated is that required for a whole class.

Demonstration 1

1 Brownian movement apparatus

1 microscope

matches

1 high intensity light source

Demonstration 2

ink

1 medicine dropper

1 450 ml. beaker

Demonstration 3

1 balloon

Demonstration 4

1 bicycle pump

1 large flask

1 one-holed rubber stopper to fit flask

glass tubing with 90° bend to fit stopper

rubber tubing to connect pump to flask

Demonstration 5

1 450 ml. beaker

Demonstration 6

meter stick

3 meter stick suspension clamps

string

1 small glass plate

1 cylindrical battery jar or large beaker

household cement

1 support rod, 36 in. (approximately), and support base

1 suspension clamp

1 set of hooked weights

Demonstration 8

1 mercury barometer

1 test tube

Demonstration 9

1 capillarity apparatus

Demonstration 10

hand lens or microscope

salt crystals

Demonstration 11

1 support rod, 36 in. (approximately), with support base

1 suspension clamp

1 coiled spring

1 set of hooked weights

Demonstration 13

1 small flask

1 one-holed stopper

glass tubing

ink

beaker, 250 ml.

Demonstration 14

2 support rods, 36 in. (approximately), with support bases

2 C clamps

wire

1 set of weights

1 propane torch or bunsen burner to heat the wire (a low voltage power supply and connecting wires may be used instead)

INVESTIGATION 10—Pressure and Volume Of A Gas

1 elasticity of gases apparatus
3 bricks or 2 sets of weights
1 Boyle's Law apparatus

INVESTIGATION 12—Specific Heat Capacity Of A Metal

1 calorimeter, double walled
1 set specific heat specimens
1 beaker, 250 ml. or tin can
1 wire gauze with asbestos center
1 bunsen burner
1 support rod 36 in. (approximately) with support base
1 ring clamp
2 Celsius thermometers
1 laboratory balance
1 set of weights
string

INVESTIGATION 13—The Melting Of Ice

1 calorimeter, double walled
1 Celsius thermometer
1 laboratory balance
1 set of weights
ice cubes

INVESTIGATION 14—Temperature And Volume Of A Gas

1 Charles' Law tube, mounted. If not available, the following may be used:
    1 glass tube with small bore, at least 20 cm. long, sealed at one end and with a drop of mercury trapping a small volume of air near the closed end
    1 Celsius thermometer
    1 meter stick
    3 rubber bands
1 apparatus for heating the tube:
    1 graduated cylinder, 1,000 ml.
    1 steam generator
    1 bunsen burner
    1 L-shaped glass tube to deliver steam to the bottom of the cylinder
    ice-cubes
    (A beaker large enough to permit immersion of the tube to a depth of at least 15 cm. may be used instead).

PHYSICS 10

ALTERNATIVE II: *PHYSICS* (PSSC) 1st OR 2nd EDITION

LABORATORY GUIDE FOR PHYSICS

COURSE OUTLINE:

1st Edition of Textbook *Physics*

Part I — The Universe

Chapter 1 — What is Physics

Chapter 2 — Time and Measurement

Chapter 3 — Space and Its Measures

Chapter 4 — *Functions and Scaling

Chapter 5 — Motion Along a Path

Chapter 7 — Mass Elements and Atoms (Section "A" only)

Chapter 9 — The Nature of a Gas

It is suggested that the additional topics which readily lend themselves to experimental approach be added — e.g. Pressure in Liquids, Archimedes' Principle, Heat and Change of State Expansion (Linear only).

Experiments:

Part I — 1, 2, 3, 5, 12, 13, 14, 17

*The main purpose of Chapter 4 is to interpret experimental data. Pupils should acquire skill in:

(i) Reading and Interpreting Graphs
(ii) Constructing Graphs from Given Data
(iii) Deriving Empirical Formulas from Graphs Based on Experimental Data

In connection with Chapter 4, teachers are encouraged to perform other experiments which would provide essential data for graphic and algebraic interpretation.

Students should be taught how to use a slide rule early in this course.

2nd Edition of Textbook *Physics*

Part I — The Universe

Chapter 1 — An Introduction to Physics

Chapter 2 — Time and Measurement

Chapter 3 — Space and Its Measures

Chapter 4 — *Functions and Scaling

Chapter 5 — Motions Along a Straight Line Path

Chapter 7 — Mass and the Elements (Omit sections 7.6-7.8)

Chapter 9 — The Nature of a Gas

It is suggested that the additional topics which readily lend themselves to experimental approach be added — e.g. Pressure in Liquids, Archimedes' Principle, Heat and Change of State Expansion (Linear only).

Experiments:

Part I — 1, 2, 3, 5, 11, 12, 13, 16

*The main purpose of Chapter 4 is to interpret experimental data. Pupils should acquire skills in:

(i) Reading and Interpreting Graphs
(ii) Constructing Graphs from Given Data
(iii) Deriving Empirical Formulas From Graphs Based on Experimental Data

In connection with Chapter 4, teachers are encouraged to perform other experiments which would provide essential data for graphical and algebraic interpretation.

Students should be taught how to use a slide rule early in this course.

CHEMISTRY 20

Alternative programs are available for *Chemistry 20.*

TEXTS:

ALTERNATIVE I: *Chemistry, An Experimental Science* (CHEM Study)
Laboratory Manual to accompany *Chemistry, An Experimental Science*

ALTERNATIVE II: *Elements of Chemistry,* Radomsky, Kass and Pickard

REFERENCES: A list of references is provided at the end of this guide.

ALTERNATIVE I: *Chemistry, An Experimental Science* (CHEM Study)

COURSE OUTLINE:

Chapter Number	Chapter Title	Experiment Number(s)	Suggested Time in Periods	Comments
	Review of Chemistry 10 CHEM Study		10	
13	Chemical Calculations	23	18	
14	Why We Believe in Atoms	24, 25 and 8*	14	Experiment 25 is to be done as a demonstration or experiment depending upon availability of equipment
15	Electrons and the Periodic Table	10* or 1**	15	
16	Molecules in the Gas Phase	11* or 2**	17	
17	The Bonding in Solids and Liquids	27	15	

*Optional experiments from *Laboratory Investigations in Chemistry* — Davis and Allen (See Chemistry 30 Alternative I outline.)

**Optional experiments from Chapter 7, *Elements of Chemistry* — Radomsky, Kass and Pickard (See Chemistry 20, Alternative II outline.)

NOTES TO TEACHERS

1. See "Notes to Teachers" under CHEM Study in Chemistry 10
2. Films:

   Molecular Spectroscopy
   The Hydrogen Atom as Viewed by Quantum Mechanics
   Ionization Energy
   Chemical Bonding
   Shapes and Polarities of Molecules
   Crystals and their Structure

SUPPLIES LIST FOR CHEMISTRY 20

(CHEM Study)

Chemicals (for 30 students)

2 litres acetone

1 lb. copper wire, 16 gauge

1500 cm^2. copper wire screen, 20 mesh

750 cm. copper sheet, 20 - 30 gauge

500 g. $CuSO_4.5H_2O$

1500 cm^2. lead sheet 1/32 in. thick

20 g. potassium hydrogen oxalate

20 g. potassium hydrogen phthalate

20 g. potassium hydrogen sulfate

20 g. potassium hydrogen tartrate

40 g. AgCl

50 g. $NaCH_3COO.\ 3H_2O$

25 g. sodium metalbisulfite, $Na_2S_2O_5$

25 g. sodium sulfate, anhydrous

100 g. $Na_2S_2O_3.5H_2O$

5 g. NaCl

5 g. KCl

5 g. $CaCl_2$

5 g. $SrCl_2$

5 g. $CuCl_2$

100 ml. HCl, concentrated

labels or glass pencil

Equipment (for 30 students)

60 burettes

30 ringstands

60 utility clamps

60 beakers, 250 ml.

30 erlenmeyer flasks, 250 ml.

30 squeeze bottles

5 burette brushes

8 DC sources

8 DC ammeter, at least 1 amp

8 variable resistors, 18 - 25 ohm

32 alligator clamps

1 sweep second clock

16 holders for electrodes, homemade

15 centigram balances

30 shoe boxes or similar

40 connecting wires, 18 in.

200 styrofoam balls, ¾ in.

200 styrofoam balls, 1 in.

600 styrofoam balls, 2 in.

8 sets molecular models

10 boxes of thumb tacks or

3000 jacks

30 sheets kraft paper, 2 ft.

30 hand spectroscope

30 burners

30 bead wire

180 test tubes, 13 mm.

30 test tube stands

1 incandescent bulb, 7½ watt

1 neon glow lamp

gas discharge tubes and transformers (optional)

1 table spectroscope (optional)

ALTERNATIVE II: *Elements of Chemistry* by Radomsky, Kass and Pickard

COURSE OUTLINE:

Chapter Number	Chapter	Experiment Number(s)	Suggested Time in Periods	Comments
1	The Fundamental Particles		5	
2	The Structure of the Atom	1	10	
3	The Periodic Classification of Elements		10	
4	Chemical Bonds Omit Sections (ii) and (iii) under "Bonding in Carbon"	2 and 4	10	Experiment 4 is optional.
5	Naming of Compounds		10	
6	Formula Weights and Volumes	5, 6, 9 and 10	15	Experiments 9 and 10 are to be done as demonstrations only. (Health hazard).
7	Experiments on Unit I and Unit II			
8	The Chemical Equation	1	10	Experiment 1 is a Teacher Demonstration.
9	Solutions	3, 5, 6 and 7	10	Experiment 3 is a Teacher or Class display. Omit generation of hydrogen from Experiment 5.
10*	The Alkali Metals	8	1	
11*	The Halogens	9, 10 and 12	1	Experiments 9 and 12 should be omitted or performed as a Teacher Demonstration.
12	Experiments on Unit III			

*These chapters should be discussed along with chapter 1, 2 and 3.

NOTES TO TEACHERS:

1. See list of films under Chemistry 20 (CHEM Study)

SUPPLIES LIST FOR CHEMISTRY 20

Elements of Chemistry — Radomsky, Kass and Pickard

Equipment List (for 30 students)

600 styrofoam balls, 2 in.
1800 styrofoam balls, 1 in.
30 erlenmeyer flasks, 125 ml.
60 erlenmeyer flasks, 250 ml.
60 small vials, 5 ml. volume
310 porcelain crucibles, 30 ml.
30 clay triangles
30 bunsen burners
30 ring stands
30 three-inch rings with clamps
30 crucible tongs
360 test tubes, 13 mm.
30 evaporating dishes, 100 mm. diameter
60 burettes, 50 ml.
30 burette stands and clamps
30 stirring rods
30 bead wires
30 cobalt glasses
1000 thumb tacks
1 large pyrex cake pan (optional)
1 pepper shaker (optional)
1 medicine dropper (optional)
1 graduate, 100 ml.
1 graduate, 10 ml.
1 graduate, 500 ml.
1 lb. cork stoppers for erlenmeyer flasks
gram balances, 0.01 (1 for 4 students)
1 Boyle's Law apparatus
1 Charles' Law apparatus
1 meter stick
1 thermometer, -10° to 100°C
1 tall glass vessel
1 beaker, 500 ml.
1 florence flask, 500 ml.
1 thistle tube
1 rubber stopper, 2-hole No. 4

Chemical List (for 30 students)

10 g. oleic acid (optional)
1 liter ethanol, denatured
10 g. lycopodium powder (optional)
100 g. Na_2CO_3
100 g. $CaCl_2$
2 liters H_2SO_4, concentrated
100 g. sulphur
1 roll copper wire, 18 gauge
1 lb. mercury
1 lb. sodium metal
1 lb. potassium metal
1 lb. calcium metal
1 roll magnesium ribbon
5 g. phenolphthalein
2 liters HCl, concentrated
2 liters HNO_3, concentrated
1 liter H_3PO_4, concentrated
1 liter $HC_2H_3O_2$, 50%
4 oz. litmus powder
2 vials red litmus paper
2 vials blue litmus paper
100 g. $NaHCO_3$
100 g. methyl orange indicator
1 lb. NaOH
100 g. KOH
100 g. $Ca(OH)_2$
1 liter NH_4OH, concentrated
100 g. NaCl
100 g. NH_4Cl
100 g. $NaC_2H_3O_2$
100 g. KCl
100 g. NH_4NO_3
100 g. $LiNO_3$
100 g. KNO_3
100 g. $NaNO_3$
100 g. NaBr
100 g. NaI
1 lb. CCl_4
100 g. MnO_2

PHYSICS 20

Alternative programs are available for Physics 20.

TEXTS:

ALTERNATIVE I: *Fundamentals of Physics*, Stollberg, Hill, Nygaard

ALTERNATIVE II: *Physics* (PSSC)

REFERENCES: A list of physics references is provided at the end of this guide.

ALTERNATIVE I: *Fundamentals of Physics*, Stollberg, Hill, Nygaard

COURSE OUTLINE:

Chapter Number	Chapter Title	Investigation Number	Suggested Time In Periods	Comments
	Mathematics basic to physics (see Physics 10 outline)		4	This fundamental material should be reviewed before starting an orderly discussion of the remainder of the course. Complete steps 1-8 of Inv. 3.
9	The Nature of Waves	*15, *16	15	Omit Section 9-6 to 9-7.
10	Sound	17, 18	6	Equipment for Investigation 17 may not be available. Schools with vocational wings will have this type of equipment.
11	The Wave Nature of Light	*19, 20, *25	10	
12	Reflection of Light	*21	10	
13	Refraction of Light	*22, *23	13	
14	Color	*24	5	
5	Forces in Fluids	8	10	Review sections covered in Physics 10 and do Section 5-9 to 5-12 and 5-20, 5-21.
15	Frontiers in Physics		5	Optional. Serves as a good basis for introduction to science fairs and enrichment projects.

*PSSC equipment may be substituted if available.

NOTES TO TEACHERS:

1. For information regarding teaching aids and laboratory work, see "Notes to Teachers" for Physics 10.
2. A summary of suggested placement of each "Investigation" in relation to theory of Physics 20 program is given below:

Investigation	Type	When the Investigation Should Be Done
The Period of a Pendulum (15)	D	Before discussing Section 9-1.
The Nature of Waves (16)	D	Before discussing Section 9-8.
Characteristics of Musical Sound (17)	D	Before discussing Section 10-7.
The Speed of Sound In Air (18)	P	After discussing Section 10-18.
Diffraction and Interference of Light (19)	D	Before discussing Section 11-7.
Polarized Light (20)	D, P	Before discussing Section 11-8.
Reflections In a Plane Mirror (21)	D	Before discussing Section 12-1.
The Refraction of Light (22)	D	Before discussing Section 13-1.
Spherical Lenses (23)	P	Before discussing Section 13-17 but not obligatory.
Spectra (24)	D	Before discussing Section 14-1.
The Wavelength of Light (25)	P, S	Anytime after discussing Section 11-15, but preferably after doing Investigation 24.
Buoyant Force (8)	D	Before discussing Section 5-9.

*D—discovery; P—application of principles; S—skill.

For further information, see section entitled INTRODUCTION TO THE TEACHER in *Solution-Answer Key and Laboratory Guide.*

SUPPLIES LIST FOR PHYSICS 20

(Stollberg, Hill, Nygaard)

1. Quantities of supplies shown are for one group of two or three students.
2. These supplies are listed according to INVESTIGATIONS.

CAUTION: In some cases there will be repetitions as supplies are used in more than one INVESTIGATION or in Physics 10 or Physics 30.

INVESTIGATION 3—The Slide Rule

1 slide rule per student

1 demonstration slide rule

INVESTIGATION 15—The Period of a Pendulum

1 support rod, 36" (approximately), with support base

4 C clamps

1 stopwatch or watch with a sweep second hand

1 hand tally counter (optional)

drilled balls of brass, steel, aluminum, wood or other materials

fine thread or fishline

heavy string to use for guy wires

INVESTIGATION 16—The Nature of Waves

white paper to serve as screen, 2 ft. x 2 ft.

1 high power light source kit (PSSC)

1 metal rod, ruler of metal dowel

1 ripple tank

1 protractor

1 stopwatch

1 glass plate about 7 in. x 9 in.

1 refraction of particles kit (PSSC)

2 sheets of carbon paper

2 sheets of white paper 8½ in. x 11 in.

masking tape

rectangular wooden blocks or paraffin blocks

4 or 5 circular objects varying in diameter from 0.5 cm. to 12-15 cm. (beakers, pans, cans, metal cylinders, pencils, etc., used in density experiments)

1 dry cell battery, 1½ volt

1 electrically-driven wave generator

1 hand stroboscope kit

1 high power light source kit

1 adjustable phase wave generator (optional)

INVESTIGATION 17—Characteristics of Musical Sound

This Investigation is a demonstration. Equipment listed is that required for a whole class.

1 oscilloscope

1 tape recorder

variable frequency audio-oscillator tuning fork of various frequencies

tape recording of various musical instruments

INVESTIGATION 18—The Speed of Sound in Air

1 resonance apparatus
2 tuning forks of different frequency

INVESTIGATION 19—Diffraction and Interference of Light

1 optical slits kit. The following equipment is required if an optical slits kit is not available:
gummed tape
fine thread
razor blades
narrow light source
red filter
green or blue filter

INVESTIGATION 20—Polarized Light

1 polarization kit. The following equipment may be used if a polarization kit is not available:
a pair of cheap sun glasses with polarizing lenses
cellophane from package wrapping
samples of clear rigid plastic
1 pair pliers

INVESTIGATION 21—Reflections in a Plane Mirror

1 sheet soft cardboard, 8½ in. x 11 in.
1 plane mirror, 2 in. x 4 in. (approximately)
1 block wood, 2 in. x 4 in. x 6 in.
unlined paper, 8½ in. x 11 in.
pins
glue
(materials from PSSC Optics Kit may be used)

INVESTIGATION 22—Refraction of Light

1 index of refraction plate
1 protractor
1 straight edge
1 sheet of soft cardboard, 8½ in. x 11 in.
unlined white paper, 8½ in. x 11 in.
pins
triangle of optical glass (optional)
(materials from PSSC Optics Kit may be used)

INVESTIGATION 23—Spherical Lenses

1 optical bench
1 double convex lens 38 mm. diameter, 5 cm. focal length
1 lens holder
1 screen and screen holder
1 object with marker
1 light source to illuminate object
1 double concave lens, 38 mm. diameter, 20 cm. focal length
(materials from a PSSC Optics Kit may be used)

INVESTIGATION 24—Spectra

1 direct vision spectroscope. (If one is not available it can be made from a sheet of dark construction paper, sticky tape, and a replica grating).

various light sources (tungsten filament lamp, infrared lamp, various spectrum tubes with power supply, a sodium flame spectrum, bunsen burner, candle, fluorescent lamp)

(materials from the PSSC Spectra Kit may be used)

INVESTIGATION 25—The Wavelength of Light

1 direct vision spectroscope

1 sheet of unlined paper, 8½ in. x 11 in.

pins

1 tungsten filament lamp, vertically mounted fluorescent lamp or a sodium flame (materials from the PSSC Spectra Kit may be used)

INVESTIGATION 8—Buoyant Force

1 set of specific gravity specimens or other heavier than water objects that can be suspended

1 laboratory balance. (If a beam balance is used the following additional equipment is required: 1 C clamp; 1 support rod, 24 in., with support base).

1 graduated cylinder, 250 ml.

1 overflow can

1 catch bucket

string

1 set of weights (not required if a spring balance is used)

ALTERNATIVE II: *Physics* (PSSC) 1st or 2nd Edition
Laboratory Guide for Physics

COURSE OUTLINE:

1st Edition of Textbook *Physics*	2nd Edition of Textbook *Physics.*
Part I — The Universe Chapter 1 — What is Physics? Chapter 2 — Time and Measurement Chapter 3 —Space and its Measures Chapter 4 — Functions and Scaling Notes to Teachers: 1. Chapter 5, "Motion Along a Path" has been deferred to Physics 30X. 2. Four to five weeks only should be allowed for coverage of Part 1. 3. Teaching for mastery of concepts of Part 1 is unnecessary since there is ample application of principles in later chapters. 4. Home, Desk, and Lab problems from the second edition of the text should be used to supplement problems from the first edition. Experiments: I — 1, 2, 3, 4	Part I — The Universe Chapter 1 — An Introduction to Physics Chapter 2 — Time and Measurement Chapter 3 —Space and its Measures Chapter 4 — Functions and Scaling Notes to Teachers: Notes 1, 2, 3 for the first edition apply also for the second edition. Experiments: I — 1, 2, 3, 4.
Part II — Optics and Waves Chapter 11 — How Light Behaves Chapter 12 — Reflection and Images Chapter 13 — Refraction Chapter 14 — Lenses Chapter 15 — The Particle Model of Light Chapter 16 — Introduction to Waves Chapter 17 — Waves and Light Chapter 18 — Interference (Omit 18.5) Chapter 19 — Light Waves (Omit Sections 19.5 to 19.8) Experiments: Part II — 1, 2, 3, 4, 5, 7, 8, 9, 10, 11 Omit Experiment 11-6 Teachers should consider the teaching of Sound as a natural extension of the study of waves. It is recommended that Chapter 10 and Investigation 18 in *Fundamentals of Physics,* Stollberg-Hill-Nygaard be studied in this course.	Part II — Optics and Waves Chapter 11 — How Light Behaves Chapter 12 — Reflection and Images Chapter 13 — Refraction Chapter 14 — The Particle Model of Light Chapter 15 — Introduction to Waves Chapter 16 — Waves and Light Chapter 17 — Interference (Omit Section 17-5) Chapter 18 — Light Waves (Omit Sections 18.5 to 18.8) Experiments: Part II — 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16 Omit Experiment 11-6 Teachers should consider the teaching of Sound as a natural extension of the study of waves. It is recommended that Chapter 10 and Investigation 18 in *Fundamentals of Physics,* Stollberg-Hill-Nygaard be studied in this course. It is suggested that Application of lenses in cameras, projectors, the eye and simple magnifier, the compound microscope and the telescope, be studied. Good sources of information of application of lenses will be found in Chapter 14 (Sections 14.4-14.7) of 1st Edition of PSSC text, and Chapter 13 of *Fundamentals of Physics,* Stollberg-Hill-Nygaard.

NOTES TO TEACHERS:

1. *Teacher's Resource Book and Guide* is available for *PSSC Physics*. This includes three kinds of information:

   (a) General discussion of the teaching of appropriate sections of the course

   (b) Solutions to problems

   (c) Laboratory suggestions

   There are five parts to *Teacher's Resource Book and Guide* for edition 1 of which parts 1, 2 and 5 are useful for Science 20 teachers. For edition 2 there are only four parts, of which parts 1 and 2 are helpful. These publications are available through the School Book Branch.

2. A series of films has been produced to accompany the PSSC text. These are available from the sources listed under Chemistry 10.

3. A series of paperback books, *The Science Study Series* has been prepared by PSSC to provide supplementary material for physics students. Reaction to this series has been quite favorable. They are published by Doubleday & Company Incorporated, Garden City, New York, and are available through the School Book Branch on special order.

SUPPLIES LIST FOR PHYSICS 20

PSSC Physics

Equipment Required for a Class of 32 Students

16 C clamps, 2 in.

16 C clamps, 4 in.

256 sheets centimeter graph paper

32 double edge razor blades

1 roll aluminum foil wrap

1 roll saran wrap

20 feet No. 40 wire

1 ream white paper, 8½ in. x 11 in.

16 sheets graph paper, log-log, 2 cycle

16 sheets cardboard, soft, 8½ in. x 11 in.

32 nails, 2 in. flat head

1 box pins, straight

1 lb. modelling clay

16 florist pins, 3 in. or No. 22 wire

16 sheets graph paper, polar

100 feet masking tape

64 sheets carbon paper

30 sheets paper (approx. 2 in. x 2 in.) or from 8½ in. x 11 in. sheets of white paper

32 metal washers

16 meter sticks

16 low power light sources

16 stoppers, cork, No. 2 or No. 4

500 feet paper recording tape, ½ in.

8 wave demonstrator kits

8 high power light sources

1 box rubber bands, assorted

16 sheets cardboard, 12 in. x 12 in.

3 dozen clothespins

36 paraffin blocks, 2½ in. x 5 in.

100 feet insulated wire, flexible, single strand

16 protractors

1 tape measure, 50 ft. (optional)

8 PSSC power supplies — 1.5, 6, 50, 100, 150, 200V D.C.

16 recording timers

16 stopwatches

16 stroboscopes, hand

16 long-short distance apparatus

16 optic kits (1965 edition) for 2nd edition or optics kit for 1st edition

8 ripple tanks

1 pliers

4 screwdrivers

1 wire cutters

CHEMISTRY 30

Alternative programs are available for this course

TEXTS:

ALTERNATIVE I: *Chemistry (Canadian Edition)*, Sienko and Plane
Laboratory Investigations in Chemistry, Davis and Allen

ALTERNATIVE II: *Chemistry, An Experimental Science* (CHEM Study)
Laboratory Manual to accompany *Chemistry, An Experimental Science*

REFERENCES: A list of chemistry references is provided at the end of this guide.

ALTERNATIVE I: *Chemistry* (Canadian Edition), Sienko and Plane
Laboratory Investigations in Chemistry, Davis and Allen

COURSE OUTLINE:

Chapter Number	Chapter Title	Experiment Number(s)	Suggested Time in Periods	Comments
Part I 2	Nature of Matter		5	
3	Atoms		10	
4	Chemical Bond		10	
5 - 5.7	Stoichiometry		10	
Part II 5.9	Stoichiometry	1 and 12	10	
6	Gases (Omit italicized sections pp. 149-150 and sections 15 and 16)	13	16	
7	Liquids		5	

Chapter Number	Chapter Title	Experiment Number(s)	Suggested Time in Periods	Comments
8	Solids (Omit sections 2, 3 and 5)	15	4	
10	Solutions (Omit sections 2, except Molarity and Normality; 3, 5, 6, 11 and 13; also omit Bronsted — Lowry and Lewis Acid Theories page 214)	2, 3 and 17	18	
12	Chemical Kinetics		10	
14	Electrochemistry	19, 20	22	
24	Group IV Elements (Omit sections 3, 5, 6, 7, 8 and 9)		8	
28	Organic Chemistry (Omit sections 3, 4 and 5)	25	17	
	Qualitative Analysis	26, 27, 28	7	

NOTES TO TEACHERS:

1. The main emphasis in this program should be on Part II as outlined above:

2. The following materials are available to teachers offering the course *Chemistry,* Sienko and Plane:
   (a) *Teacher's Guide to Laboratory Investigations,* Davis and Allen (School Book Branch)
   (b) *Instructor's Manual to Accompany Chemistry,* Sienko and Plane (McGraw - Hill Book Company, Inc.)
   (c) *Study Guide for Sienko and Plane, Chemistry,* T. R. Russell (McGraw - Hill Book Company, Inc.)

3. Appropriate films may be selected from the CHEM Study list.

SUPPLIES LIST FOR CHEMISTRY 30

(Sienko and Plane)

Equipment List (for 30 students)

360 test tubes, 13 mm.
180 test tubes, 18 mm.
30 test tube racks
90 medicine droppers
60 beakers, 100 ml.
30 beakers, 250 ml.
30 squeeze wash bottles
30 Y-tubes
30 ring stands
30 pressure clamps
30 graduates, 100 ml.
120 glass tubing, 6 mm.
30 funnels, 75 mm.
30 watch glasses, 75 mm.
30 Bunsen burners
30 clamps, utility
30 bead wires
30 stirring rods
30 Erlenmeyer flasks, 250 ml.
30 test tube brushes
30 thermometers, -10° to 100°C
30 rubber stoppers, 1-hole No. 6
90 ft. rubber tubing, ¼ inch
900 styrofoam spheres, 2 inch
450 styrofoam spheres, 1 inch
30 packets pipe cleaners or 3,000 toothpicks

30 burettes, 50 ml.
30 pipettes, 25 ml.
30 pro-pipettes, (optional)
30 weighing vials
30 graduates, 10 ml.
15 ft. tygon tubing, ½ inch diameter
30 rings with clamp, 2 inch
30 wire gauges
1 graduate, 250 ml.
1 volumetric, 1,000 ml.
1 platform balance, 0.1 gram, (1 for 8 students)
1 barometer
water bath (1 for 2 students)
atomic models (1 set for 4 students)
0.01 gram balance (1 for 4 students)
D.C. voltmeter, 0-5v, (1 for 4 students)
copper wire, coated (2 ft. for 4 students)
alligator clamps (2 for 4 students)
burette brush (1 for 4 students)
1 graduate, 500 ml.
gummed labels or grease pencils
bottles, 1 quart or larger, (1 for 2 students)
10 ft. wire twist
1 oz. stopcork grease for burettes
1 lb. cork stoppers for 13 mm. test tubes
1 lb. cork stoppers for 18 mm. test tubes

Chemical List (for 30 students)

500 g. $CuSO_4.5H_2O$
2 liters NH_4OH, concentrated
2 liters H_2SO_4, concentrated
4 liters HCL, concentrated
2 liters HNO_3, concentrated
100 sheets filter paper, qualitative (11 cm.)
10 g. $Ca(NO_3)_2$ (or chloride)
10 g. $Ba(NO_3)_2$ (or chloride)
10 g. KNO_3 (or chloride)
10 g. $Cu(NO_3)_2$ (or chloride)

3 lbs. NaOH, reagent grade
1 cylinder oxygen (Note 4)
1 cylinder CO_2 (or dry ice) (Note 5)
stopcork grease for burette
10 g. $ZnSO_4$
100 g. $AgNO_3$
100 g. $Pb(NO_3)_2$
100 g. $Al(NO_3)_3$
100 g. $Cu(NO_3)_2$
100 g. $FeSO_4,.(NH_4)_2SO_4$, or $FeSO_4$

100 g. benzoic acid

1 pint household bleach (Note 7)

100 g. methanol

1 lb. KOH (optional)

10 g. $Hg_2(NO_3)_2$

100 g. NaBr

10 g. Na_2CO_3

10 g. iodine

10 g. Na_2SO_4

10 g. $SnCl_2$

10 g. NaI

10 g. $NaNO_3$

1 lb. zinc metal, 1/100 inch foil

2 lbs. copper metal, 1/100 inch foil

100 g. $Fe(NO_3)_3$

100 g. $Mg(NO_3)_2$

5 lbs. NaCl (tech.)

1 lb. NaCl (reagent grade)

2 liters ethanol (denatured)

5 g. $K_3Fe(CN)_6$

5 g. $K_4Fe(CN)_6$

5 g. phenolphathalein

30 g. cyclohexane

30 g. cyclohexene

1 pint benzene

10 g. $KMnO_4$

12 ml. Br_2 Liquid (Note 6)

1 liter CCl_4

10 g. $K_2Cr_2O_7$

200 g. 1 butanol (n-butyl alcohol)

200 g. 2 butanol (sec-butyl alcohol)

200 g. 2 methul-2 propanol (tert. butyl alcohol)

1 lb. lead metal, 1/100 inch foil

25 g. silver metal, 1/100 inch foil

1 roll Cu wire, 18 gauge

100 g. potassium hydrogen phthalate

30 plastic bags, 1 quart size (obtain locally)

natural or L.P. gas

NOTES TO TEACHERS:

1. Unless otherwise specified the salts may be hydrated.

2. Quantities listed allow for "normal" waste in the lab. Poor supervision can result in the use of several times the required amount.

3. Quantities listed do not correspond to commercial packages. For most chemicals the most economical size is the 1 lb. (or 500g.) bottle. Avoid larger sizes as wastage in use is greater, especially for deliquescent materials such as NaOH.

4. Oxygen may be obtained locally from a welding supply company. The amount required is 1 to 2 cubic feet. Alternatively a lecture demonstration bottle (with regulator) may be used.

5. Carbon dioxide may be obtained as dry ice or as bottled gas. The former is easily obtained but requires thought in its application.

6. Bromine comes as a liquid or in sealed capsules. Bottles are more convenient since it is difficult to reseal a capsule. Since Br_2 is a hazardous chemical, it may be more satisfactory to make up bromine water as required. (See Teacher's Guide for *Chemistry, An Experimental Science*, p. 379).

7. Chlorine water can be prepared by bubbling chlorine gas through cold water, but a satisfactory substitute is ordinary household bleach solution (5% available chlorine) diluted with 4 parts of water for 1 part bleach solution.

ALTERNATIVE II: *Chemistry, An Experimental Science* (CHEM Study)
Laboratory Manual to accompany *Chemistry, An Experimental Science*

COURSE OUTLINE:

Chapter Number	Chapter Title	Experiment Numbers	Suggested Time in Periods	Comments
7	Energy Effects in Chemical Reactions	12, 13	15	
8	The Rates of Chemical Reactions	14	20	
9	Equilibrium in Chemical Reactions	15	25	
10	Solubility Equilibria	16	19	
11	Aqueous Acids and Bases	17, 18, 19	25	
12	Oxidation-Reduction Reactions	20, 21	19	
18	The Chemistry of Carbon Compounds	28, 29	25	
19	The Halogens	30, 31	13	

NOTES TO TEACHERS:

1. See "Notes to Teachers" under Chemistry 10.

2. Films:

Molecular Motions
Introduction to Reaction Kinetics
Equilibrium
Acid Base Indicators
Electrochemical cells
Mechanism of an Organic Reaction
Synthesis of an Organic Compound
Bromine — Elements from the Sea

SUPPLIES LIST FOR CHEMISTRY 30
(CHEM Study)

Chemicals List

1000 ml. acetic acid, glacial
500 ml. acetone
0.1 g. alizarin yellow r
30.0 g. ammonium chloride
1.0 g. ammonium dichromate
16.0 g. ammonium nitrate
10.0 g. barium nitrate
50 ml. benzene
2.0 g. bromine
150 ml. 1-butanol
150 ml. 2-butanol
150 ml. t-butanol
40.0 g. calcium carbonate, marble chips
100.0 g. calcium chloride, anhydrous No. 12 mesh
2.0 g. calcium hydroxide powder, tech.
600 ml. carbon tetrachloride
lecture bottle chlorine, bottled
1.0 g. citric acid
30 ft. copper wire, B & S 22 gauge
1 lb. copper wire, B & S 16 gauge
750 cm^2 copper sheet, B & S 20-30 gauge
120.0 g. copper II nitrate, $Cu(NO_3)_2.3H_2O$
30 ml. cyclohexane
30 ml. cyclohexene
1000 ml. ethanol
10 ml. ethyl acetate
80 mg. ferric nitrate, $Fe(NO_3)_3.9H_2O$
10.0 g. ferrous sulfate, $FeSO_4.7H_2O$
1000 ml. hydrochloric acid, conc. 12M
50 ml. hydrogen peroxide, 3% stabilized
0.25 g. indigo carmine
35.0 g. iodine
1000 cm^2 lead, sheet 1/32 inch thick
30.0 g. lead dioxide
150.0 g. lead nitrate
10.0 g. magnesium oxide
20.0 g. manganous sulfate, $MnSO_4.H_2O$
250 ml. methanol
1.0 g. methyl orange
1000 ml. nitric acid, conc. 15 ml.
0.1 g. orange IV
1.0 g. oxalic acid, $H_2C_2O_4.2H_2O$
2.0 g. phenolphthalein
3.0 g. potassium bromide
20.0 g. potassium chromate
30.0 g. potassium dichromate
2.0 g. potassium hydrogen phthalate
2.0 g. potassium hydrogen tartrate
50.0 g. potassium hydroxide
50.0 g. potassium iodate
150.0 g. potassium iodide
2.0 g. potassium permanganate
1.0 g. potassium thiocyanate
165 cm^2 silver sheet, B & S 20-30 gauge
17.0 g. silver acetate
80.0 g. silver nitrate
3.0 g. sodium
100.0 g. sodium acetate, $NaCH_3COO.3H_2O$
3.0 g. sodium bromide
10.0 g. sodium carbonate, $Na_2CO_3.H_2O$
6.0 g. sodium chloride
1.0 g. sodium hydrogen carbonate, anhydrous
100.0 gms. sodium hydroxide pellets
50 ml. sodium hypochlorite, commercial bleach 5%
15.0 g. sodium iodide
30.0 g. sodium metabisulfite (sodium hydrogen sulfite)
10.0 g. sodium oxalate
2.0 g. sodium phosphate, tribasic $Na_3PO_4.12H_2O$
30.0 g. sodium sulfide, $Na_2S.9H_2O$
9.0 g. sodium sulfite, anhydrous
5.0 g. starch, soluble
1000 ml. sulfuric acid, conc. reagent 18M
30 ml. toluene
300 cm^2 zinc, sheet 2 x 8 cm.
150.0 g. zinc nitrate, $Zn(NO_3).6H_2O$

Miscellaneous List

100 boiling chips

2 sheets emery cloth, fine, 2 x 3 in.

60 sheets filter paper, 11 cm. diam.

8 rolls hydrion

30 boxes labels

100 pieces litmus paper

30 boxes matches

¼ lb. steel wool, No. 00

Glassware List

30 beakers, 100 ml.

30 beakers, 250 ml.

30 beakers, 400 ml.

48 bottles, 4 oz. screw cap

12 bottles, large

30 condensers, small

150 dropper bottles, 50 ml.

30 flasks, 250 ml.

30 funnels, 75 mm. diam., short stem

30 funnels, separatory, 25 to 50 ml.

30 glass stirring rods, 6 mm., 15 to 20 cm. long

30 (4 ft. lengths) glass tubing, 6 mm.

25 (4 ft. lengths) glass tubing, 10 mm.

30 graduates, 10 ml.

30 graduates, 25 ml.

15 graduates, 100 ml.

30 medicine droppers

180 test tubes, 13 x 100 mm., soft glass

120 test tubes, 13 x 100 mm., hard glass

120 test tubes, 18 x 150 mm., hard glass

30 test tubes, 25 x 200 mm.

8 U tubes, 150 mm. high, 1 cm., diam.

150 vials, ½ x 4½ inches

Hardware List

32 alligator clamps

30 burners

16 carbon electrodes

30 clamps, utility

40 connecting wires, 18 in.

8 D.C. source, 12 volts

16 porous cups, 75 ml.

8 U-tube salt bridges

8 D.C. voltmeters, 100 ohm/volt, 0-5 volt

30 ring stands, 18 in.

30 ring supports, 4 in.

30 safety glasses

30 squeeze bottles, 125 ml. (dispensing bottle)

30 squeeze bottles, 250 ml. wash bottle

150 stoppers, cork No. 3

30 stoppers, cork No. 10

30 test tube brushes

30 test tube holders

30 test tube racks

30 thermometers, -10°C to 110°C

30 wire gauze, 5 x 5 inch with asbestos centre

15 balances, centigram, 0.01 g.

5 balances, platform, 0.01 g.

1 centrifuge (optional)

hot plates, several up to 30

1 large clock, with sweep second hand

PHYSICS 30

Note that alternative programs are available.

TEXTS:

ALTERNATIVE I: *Frontiers of Physics,* Stollberg, Hill

ALTERNATIVE II: *Physics* PSSC
Laboratory Guide for Physics PSSC

REFERENCES: See list provided at the end of the Curriculum Guide.

ALTERNATIVE I: *Frontiers of Physics,* Stollberg, Hill

COURSE OUTLINE:

Chapter Number	Chapter Title	Investigation Number(s)	Suggested Time in Periods	Comments
	Some basic physics (see Physics 10 Outline)		4	This fundamental material should be reviewed before starting an orderly discussion of the remainder of the course. Complete all steps in Inv. 3.
1	Motion and Measurement	4*	16	
2	Force and Motion	7, 8	16	
3	Work and Energy	10	16	
4	Matter and Energy	11, 12	12	
6	Forces in Equilibrium	15, 16, 17	16	
7	Forces and Simple Machines	18	4	Do only Sect. 7-1 to 7-7 inclusive.
9	Magnetism and Electromagnetism	22, 23	8	
10	Electric Energy and Electric Circuits		12	
11	Direct Current	24, 25, 26	16	
12	Moving Charges in Magnetic Fields	27, 28	12	
13	Alternating Current		4	Do only Sect. 13-1 to 13-6 inclusive.
16	Particles, Accelerators and Holes		10	Do only Sect. 16-1 to 16-6 and 16-13 to 16-17.

NOTES TO TEACHERS:

1. For information regarding teaching aids and laboratory work see "Notes to Teachers" under Physics 10.

2. A summary of suggested placement of each "Investigation" in relation to the theory in the Physics 30 program is given below:

Investigation	Type	When the investigation should be done
Accelerated Motion (4)	D	Before discussing Section 1-8.
Weight and Mass (7)	D	Before discussing Section 2-1.
Force and Acceleration (8)	D	Before discussing Section 2-8.
Mechanical Power Developed by an Engine (10)	P	After discussing Section 3-8.
Electric Charges (11)	D	Before discussing Section 4.
The Cloud Chamber (12)	D	Before discussing Section 4-16.
The Addition of Concurrent Forces (15)	D	Before discussing Section 6-1.
Equilibrium with Parallel Forces (16)	D	Before discussing Section 6-10.
Center of Gravity (17)	D	Before discussing Section 6-13.
The Force of Friction (18)	D	Before discussing Section 7-1.
The Magnetic Field of Permanent Magnet (22)	P	Before discussing Section 9-5.
The Magnetic Field Surrounding an Electric Current (23)	D	Before discussing Section 9-10.
Introduction to Electric Circuits (24)	D, S	Before discussing Section 11-9.
Potential Difference and Current in a Network (25)	D	Before discussing Section 11-16.
The Accurate Measurement of Resistance (26)	D, P	After discussing Section 11-20.
The Operation of a Simple Electric Motor (27)	D, P	Before discussing Section 12-10.
Electromagnetic Induction (28)	D	Before discussing Section 12-15.

D—discovery; P—application of principles; S—skills.

Further information is available in *Teacher's Laboratory Guide and Answer Key.*

SUPPLIES LIST FOR PHYSICS 30

(Stollberg, Hill)

INVESTIGATION 3 — The Slide Rule

1 slide rule per student

1 demonstration slide rule

INVESTIGATION 4 — Accelerated Motion

(See Physics 10 supply list)

INVESTIGATION 7 — Weight and Mass

(See Physics 10 supply list)

INVESTIGATION 8 — Force and Acceleration - Metric Units of Mass and Force

2 weight hangers for slotted weights

2 sets of slotted weights

nylon fishline

1 single fixed pulley with low friction, light weight and large diameter (a wheel and axle may be used)

1 stopwatch

1 meter stick

1 support rod, 36 in. (approximately), with support base

gummed tape to put over slots in weights

1 C clamp

1 right angle type rod clamp

INVESTIGATION 10 — The Mechanical Power Developed by an Engine

1 small electric motor (if one is not available a toy steam engine, an electric motor from a Meccano set or a 6V car heater motor from an auto wrecker may be used)

1 pulley for motor

2 spring balances (the size of spring balance used will depend on the power of the motor available)

1 leather brake belt (not necessary if motor has low power)

1 revolution counter (not necessary if the motor is of low power)

1 stopwatch or watch with a second sweep hand

1 vernier caliper or other instrument for measuring the pulley diameter

1 support rod, 36 in. (approximately), with support base

1 C clamp (not necessary if the motor has low power)

1 pendulum clamp

string

INVESTIGATION 11 — Electrical Charges

2 hard rubber rods

1 electroscope

1 catskin exciting pad

1 support rod with support base

1 suspension clamp

string

strips of flexible vinyl plastic (the kind used for freezer and dry cleaner bags); strips of fiberglass curtain fabric or of acetate ribbon (the cheap kind used to tie gift packages); plastic bags large enough to fit over one hand; two clothes hangers. (A straight metal rod should be cut from one hanger and a sling to support the hard rubber rod and metal rod should be made from the other one).

INVESTIGATION 12 — The Cloud Chamber

1 cloud chamber
dry ice (can be obtained at a local dairy)
1 light source with a strong light beam
isopropyl alcohol
alpha and beta radioactive sources

INVESTIGATION 15 — The Addition of Concurrent Forces

2 support rods, 36 in. (approximately), with support bases
2 suspension clamps
2 spring balances
2 C clamps
nylon fishline
1 set of hooked weights
1 sheet of heavy cardboard (not required if the apparatus is set up against a wall)

INVESTIGATION 16 — Equilibrium with Parallel Forces

1 meter stick
3 meter stick suspension clamps
string
1 set of hooked weights
1 metal ball of unknown mass, with hook
1 laboratory balance
1 support rod, 36 in. (approximately), with support base
1 suspension clamp
1 C clamp

INVESTIGATION 17 — The Center of Gravity

1 set of weights
1 nail about 3 in. long
1 piece of cardboard, about 8½ in. x 11 in.
1 meter stick
1 pair of scissors
thread or thin string

INVESTIGATION 18 — The Force of Friction

1 board, 1 in. x 6 in. x 3 ft.
1 set of hooked weights
1 set of slotted weights
1 weight hanger
1 block, 2 in. x 4 in. x 6 in., with hook
1 rod type pulley
1 table clamp for holding rod type pulleys
string
1 laboratory balance

INVESTIGATION 22 — The Magnetic Field of a Permanent Magnet

1 pair bar magnets
1 small compass
white paper, 8½ in. x 11 in.

INVESTIGATION 23 — The Magnetic Field Surrounding an Electric Current

1 low voltage power supply or old dry cell
bell wire
6 small compasses
1 knife switch
1 sheet of cardboard, 8½ in. x 11 in. with a hole punched in the center large enough for bell wire to pass through
1 large nail

INVESTIGATION 24 — Introduction to Electrical Circuits

1 DC ammeter
1 DC voltmeter
1 low voltage DC power supply
connecting wires
1 knife switch
1 resistor or resistance box

INVESTIGATION 25 — Potential Difference and Current in a Network

1 low voltage DC power supply
4 resistors of known resistance (2 of them to be equal in resistance)
1 knife switch
connecting wires
1 DC ammeter
1 DC voltmeter

INVESTIGATION 26 — The Accurate Measurement of Resistance

1 Wheatstone bridge with slide wire switch
1 galvanometer
1 protective resistor if galvanometer is not protected
1 low voltage power supply
2 knife switches
1 variable resistance box
2 premeasured "unknown" resistors
connecting wires

INVESTIGATION 27 — The Operation of a Simple Electric Motor

1 St. Louis motor
1 low voltage DC power supply
connecting wires
1 knife switch
1 magnetic compass

INVESTIGATION 28 — Electromagnetic Induction

1 galvanometer without built-in protective resistor

bell wire (at least 10 ft.)

1 protective resistor, 4,000 - 50,000 ohms

1 low voltage DC power supply

1 large nail

1 bar magnet

1 knife switch

ALTERNATIVE II: *Physics,* PSSC

COURSE OUTLINE:

1st Edition of Textbook, *Physics*	2nd Edition of Textbook, *Physics*
Part I — The Universe	Part I — The Universe
Review, not *more* than 2 weeks	Review, not *more* than 2 weeks
Chapter 2 — Time and Measurement Sec. 4 and 7	Chapter 2 — Time and Measurement Sec. 4 and 7
Chapter 3 — Space and Its Measurement Sec. 5 to 7 inclusive	Chapter 3 — Space and Its Measurement Sec. 5 to 7 inclusive
Chapter 4 — Functions and Scaling Sec. 3 and 4	Chapter 4 — Functions and Scaling Sec. 3 and 4
New Work	**New Work**
Chapter 5 — Motion Along A Path Sec. 1 to 7, omitting 8	Chapter 5 — Motion Along A Straight-Line Path Sec. 1 to 8 inclusive
Chapter 6 — Vectors Sec. 1 to 6 inclusive	Chapter 6 — Motion in Space Sec. 1 to 7 inclusive
Experiment 1-5	Experiment 1-5
Part III — Mechanics	Part III — Mechanics
Chapter 20 — Newton's Law of Motion	Chapter 19 — Newton's Law of Motion
Chapter 21 — Motion at the Earth's Surface Sec. 1 to 8 inclusive	Chapter 20 — Motion at the Earth's Surface Sec. 1 to 8 inclusive
Chapter 22 — Universal Gravitation and Solar System Sec. 6 to 11, read 1 to 5	Chapter 21 — Universal Gravitation and Solar System Sec. 6 to 11, read 1 to 5
Chapter 23 — Momentum and Conservation of Momentum Sec. 1 to 4, read 5 to 8	Chapter 22 — Momentum and Conservation of Momentum Sec. 1 to 4, read 5 to 7 and rockets
Chapter 24 — Work and Kinetic Energy Sec. 1 to 8, 10 and 11	Chapter 23 — Work and Kinetic Energy Sec. 1 to 8, 10 and 11
Chapter 25 — Potential Energy	Chapter 24 — Potential Energy
Chapter 26 — Heat, Molecular Motion, Conservation of Energy	Chapter 25 — Heat, Molecular Motion, Conservation of Energy

Physics 30X — Using 1st Edition

Experiments:

III — 2, 3, 4, 5, 6, (8), 9, 10, 11, 12, 13, 14

Part IV — Electricity and Atomic Structure

Chapter 27 — Some Qualitative Facts About Electricity

Chapter 28 — Coulomb's Law and the Elementary Electric Charge
Sec. 1 to 7 inclusive

Chapter 29 — Energy and Motion of Charges in Electric Fields
Sec. 1 to 8, 13 and 14

Chapter 30 — The Magnetic Field

Chapter 31 — Electro-magnetic Induction and Electro-magnetic Waves

Experiments:

IV — 1 to 10

Physics 30X — Using 2nd Edition

Experiments:

III — 1, 2, 3, 4, 5, (7), 9, 10*, 11, 12, 13

Part IV — Electricity and Atomic Structure

Chapter 26 — Some Qualitative Facts About Electricity

Chapter 27 — Coulomb's Law and the Elementary Electric Charge
Sec. 1 to 7 inclusive

Chapter 28 — Energy and Motion of Charges in Electric Fields
Sec. 1 to 7 inclusive

Chapter 29 — Electric Circuits
Sec. 4 and 5

Chapter 30 — The Magnetic Field

Chapter 31 — Electro-magnetic Induction and Electro-magnetic Waves

Experiments:

IV — 1, 2, 3, 4, (5*), (6*), 7, (8*), (9*), 10, 11, 12, 13

*Do not appear in 1st edition.

NOTES TO TEACHERS:

1. Exhaustive treatment of Chapters 30, 31 is not necessary.
2. As much quantitative treatment should be attempted as the teacher considers advisable, in Chapters 30, 31.
3. See notes under PSSC Physics in the Physics 20 program.
4. Further information regarding laboratory equipment for offering PSSC Physics, is provided below.

SUPPLIES LIST FOR PHYSICS 30 (PSSC)

Table I indicates equipment required for either the 1st edition or the 2nd edition. Table II is additional equipment for the 1st edition only and Table III additional equipment for the 2nd edition only. The equipment is for a class of 32 students.

TABLE I

Common for 1st and 2nd edition

12 spools thread, No. 15, 100 yds. per spool
200 sheets graph paper, centimeter divisions
1 ream onion skin paper
1 package carbon paper
200 sheets graph paper, translucent
200 sheets graph paper, polar
500 feet cord, white, glazed
12 rolls tape, cellulose, ¾ in. x 1,296 in.
50 clothespins
4 large rolls masking tape
16 protractors, plastic, 6 in.
2 electrostatics class kits
8 electroscopes
16 ring stands, 36 in.
32 flask clamps
8 high powered lamps with socket and cord
1 pkg. nylon filament, 102 yards
500 feet wire, stranded, insulated, 20 gauge
8 pinch clamps, horsecock
64 clip leads, 2 in.
32 battery clips
16 weights, ¼ lb.
16 timers, 1½ volt
1 pkg. recording tape, ½ in. x 500 in.
32 C clamps, 4 in.
8 balances, triple beam with extra range
20 feet rubber tubing, ⅜ in.
24 pieces glass tubing, 6 mm. O.D. by 35 cm.
1 lb. stoppers, rubber, No. 7, 2-hole
8 PSSC power supply, 200, 150, 100, 50, 6 and 1.5V D.C.
16 wood bars, 1¾ in. x 25/32 in. x 3 in.
8 dynamic cart kits
8 recording timer kits
16 meter sticks
8 inertial balance kits

TABLE II

1st edition only

8 dosimeters
8 dosimeter adapter kits
8 resistors, 1 meg ohm, ½ w.
8 potential difference kits
8 cardboard cartons, 18 in. x 18 in. x 18 in.
8 boards, 1 in. x 1 in. x 12 in.
16 stopwatches
96 C clamps, 2 in.
8 centripetal force kits
16 collision in two-dimension kits
8 mass of the electron kits
16 helical steel spring kits
24 beakers, 600 ml.
32 metal rods, 6 in.
16 clamp holders
1 tube quick drying glue
1 roll aluminum foil
8 D.C. ammeters, 0 to 5 amps
16 pieces cardboard, 8½ in. x 11 in.
1 pkg. rubber bands, assorted sizes
32 bricks
16 rulers
8 dishes, approximately 8 in. x 8 in. x 2 in.
8 electrodes, copper
8 flasks, boiling, 500 ml.
8 flasks, Erlenmeyer, 500 ml.
24 graduated cylinders, 100 ml.
8 rheostat, Vernier, 5 ohm/100 watt
8 flasks, ring, 7 in.
16 current balances
16 low power light source kits
16 tangent galvanometers
16 sheets sandpaper, fine
16 compasses
8 air core solenoids
16 dowel sets
10 lb. sulfuric acid, concentrated
8 voltmeters, range 0.6, 10, 200V D.C.
32 clip leads, 4 ft.
8 C clamps, 6 in.
32 wedges, wood

TABLE III

2nd edition only

8 Coulomb's law apparatus
16 sheets Masonite, 8 in. x 15 in. (optional)
8 Millikan apparatus
8 time and charge appartus
8 milliammeters, 0-1 ma.
16 clamps, burette
16 clamp slides, resistance

SCIENCE 11

TEXTS:

Basic Science for Secondary Schools, Hogg et al.

Laboratory Manual to Accompany Basic Science for Secondary Schools, Hogg et al.

REFERENCES: (i) *Explaining the Sciences,* Brandwein et al.

(ii) *Modern Biology,* Moon, Otto and Towle (1963 Edition)

NOTE: Students may use the text *Physical Science for Secondary Schools,* Hogg, Cross and Davis and *Supplement to Physical Science for Secondary Schools* in lieu of *Basic Science for Secondary Schools,* Hogg et al.

COURSE CONTENT:

UNIT I: The Earth As It Began

1. The Earth — Its Origin (Optional)
2. Waters of the Earth
3. The Earth's Atmosphere

UNIT II: Earth, The Abode of Man

4. The Earth — Its Shape and Motion
5. Rocks of the Earth (1)
6. Rocks of the Earth (2)
7. The Changing Earth (Optional)
8. The Formation of Mountains
9. The Record of Rocks (Optional)
10. Earth History (Optional)

UNIT III: Weather

11. Winds and Air Masses
12. Fronts and Storms
13. Weather Forecasting (1)
14. Weather Forecasting (2) (Optional)
15. What is Climate?

UNIT IV: Chemistry and Some Industries

16. Oxygen and Hydrogen
17. Water, An Important Compound
18. A Chemist's Language and Shorthand
19. The Structure of the Atom (Optional)
20. Fuels: Solid, Liquid and Gaseous
21. Some Chemieal Industries
22. Metals (Optional)
23. Foods, Drugs and Antiseptics

UNIT V: Electricity

24. Magnetism
25. Static Eleetricity
26. Current Electricity
27. Heat and Light from Electrieity
28. Power from Electricity

UNIT VI: Communication (Optional)

29. What is Sound?
30. Sound Instruments
31. The Telephone and Some Electronic Devices
32. Radio and Television (Optional)

UNIT VII: Atoms and Stars

33. Power from Atoms
34. The Sun
35. The Solar System
36. Stars and Galaxies

UNIT VIII: Biology — The Study of Life

37. The Living Cell
38. The Classification of Plants and Animals
39. Plants
40. Animals
41. Heredity — Transmission of Characteristics

Experiments:

Experimental work to be done ineludes those experiments listed in the laboratory manual. However, experiments 5, 18 and 19 should be considered as optional.

NOTES: Teaehers should feel free to exercise considerable freedom in the development of this course. They may wish to give little prominence to certain units and deal with other units in greater depth. Teachers may also wish to give less time and attention to some seetions of the course in order to have time to pursue those sections regarded as optional.

Experimentation in this course may serve a number of purposes sueh as student motivation, exploration of the new ideas and coneepts as well as verifieation of data already known.

Apparatus and materials to be used in the experimental phase of this course will be found in any well-equipped physical and biological science laboratory.

PHYSICS 22

Physics 22 is designed for students in vocational high schools who are taking programs which articulate with the Institute of Technology (e.g., drafting, electronics and machine shop). It is expected that students in other programs may elect this course. Teachers should feel free to adjust the content and method of presentation to the capabilities of their classes; however, it is felt that students in the articulated programs should cover the program as outlined.

TEXTS:

Physics, An Exact Science, White
Laboratory Exercises to accompany *Physics, An Exact Science*

or

****Physics, An Experimental Science***, White
Laboratory Exercises to accompany *Physics, An Experimental Science*

COURSE OUTLINE:

1. Introduction — Lessons 3, 4*
2. Properties of Matter — Lessons 4, 5*, 6, 7*
3. Light — Lessons 1, 2, 3*, 4, 5*, 6, 7, 8*, 9, 10*, 11, 12, 13*, 14, 15*

*The lessons marked with an asterisk are laboratory exercises.

NOTES TO TEACHERS:

1. Teachers of Physics 22 should put proper and sufficient emphasis on problem-solving and laboratory activity.
2. "Britannica Films" are a useful aid for lessons in this course. Sound motion picture films of thirty minutes each are available for use in conjunction with any or all of the physics lessons.

**Please note that the course has *not* been revised and teachers using *Physics, An Experimental Science* should choose the equivalent lessons to those found in *Physics, An Exact Science*.

PHYSICS 32

As for Physics 22, Physics 32 is designed for students in vocational high schools who are taking programs which articulate with the Institute of Technology and is expected to be equivalent to the Year "A" Physics program in the technical institutes. Information on course content and laboratory exercises follows:

TEXTS:

Physics, An Exact Science, White
Laboratory Exercises to accompany *Physics, An Exact Science*

or

******Physics, An Experimental Science,* White
Laboratory Exercises to accompany *Physics, An Experimental Science*

COURSE OUTLINE:

1. Mechanics
   Lessons 1, 2*, 3, 4*, 5, 6, 7, 8*, 9, 10, 11*, 12, 13*, 14, 15, 16*, 17, 18*, 19, 21, 23, 24, 27, 29, 30*, 31, 32, 33*
2. Electricity
   Lessons 1, 2, 3, 4*, 5, 6*, 7, 9
3. Heat
   Lessons 1, 3, 7*, 8, 9, 11, 12*

*The lessons which are marked with an asterisk are laboratory experiments.

NOTES TO TEACHERS:

Teachers should give proper and sufficient emphasis to problem-solving and laboratory activity. "Britannica Films" of thirty minutes each are available for use in conjunction with any or all lessons.

******Please note that the course has *not* been revised and teachers using *Physics, An Experimental Science* should choose the equivalent lessons to those found in *Physics, An Exact Science.*

REFERENCES

CHEMISTRY

Atoms, Crystals and Molecules, Drummond Jr., (American Education Publications, Education Centre, Columbus 16, Ohio, U.S.A.) (Paperbound)

Chemical Bonding, Companion, (McGraw-Hill)

The Chemical Elements, (Science Service, 1719 N. Street, N.W., Washington 6, D.C.)

A New Dictionary of Chemistry, Miall and Miall, (Longmans Canada Limited, 137 Bond Street, Toronto 2, Ontario.)

Basic Principles of Chemistry, Gray and Haight, (W. A. Benjamin Inc., One, Park Avenue, New York.)

Chemistry, A Modern Approach, Smoot, Price and Barrett, (Charles E. Merrill Publishing Co., Columbus Ohio.)

Teaching Chemistry With Models, Sanderson, (Van Nostrand)

Why Do Chemical Reactions Occur?, Campbell, (Prentice-Hall)

Chemistry, Choppin and Jaffe, (W. J. Gage Ltd.)

Chemistry, Principles and Concepts, Sturchis, Nechamkin and Dorfman, (Prentice-Hall)

Electronic Structure, Properties and the Periodic Laws, Sisler, (Reinhold College Textbook Dept.)

Chemical Systems, Chemical Bond Approach Project, Webster, (McGraw-Hill Publishing)

Basic Modern Chemistry, Madras, Hall and Holcomb, (McGraw-Hill)

General Chemistry, Brown, (Charles E. Merrill Books Inc.)

Chemical Bonding and the Geometry of Molecules, Ryschkewitsch, (Reinhold) (Paperbound)

Acids, Bases and the Chemistry of the Colvalent Bond, Vander Werf, (Reinhold) (Paperbound)

Nuffield Chemistry, (Published for the Nuffield Foundation by Longmans/Penguin Books)

Successful Devices in Teaching Chemistry, Westmeyer, (J. Weston Walch, Box 1075, Portland, Maine)

College Chemistry, Mahan, (Addison-Wesley)

Chemistry, An Investigative Approach, Cotton and Lynch, (Thomas Nelson and Sons, Don Mills, Ontario)

Chemistry Experiments and Principles, O'Connor et al., (Raytheon Education Company)

(The above two titles are revisions of CHEM Study and should be procured for class use)

PHYSICS

Physics, Fundamentals and Frontiers (Teacher's Edition), Stollberg and Hill, (Houghton Mifflin)

Modern Physics (Teacher's Edition), Dull, Metcalf and Williams, (Holt, Rinehart and Winston)

Physics, Taffel, (Allyn and Bacon)

Foundations of Physics, Lehrman and Swartz, (Holt, Rinehart and Winston)

The Science of Physics, Beiser, Addison, (Wesley)

The Teaching of Physics, Warren, (Butterworths)

Nuffield Physics, (Published for the Nuffield Foundation by Longmans/Penguin Books)

Great Experiments in Physics, Shamos, (Holt, Rinehart and Winston)

TESTING AND EVALUATION

Testing and Evaluation for the Sciences, Hedges, (Wadsworth Publishing Co., Inc., Belmont, California)

Understanding Science: Teaching and Testing, Nedelsky, (Harcourt, Brace and World)

Taxonomy of Education Objectives, Bloom, (David McKay Co., Inc., 119 West 40th Street, New York 18, New York.)

TEACHING OF SCIENCE

Teaching High School Sciences, A Sourcebook for the Physical Sciences, Moreholt, Brandwien, Joseph, (W. J. Gage Limited, 1500 Birchmount Road, Box 550, Scarborough, Ontario.)

Teaching High School Sciences, A Sourcebook for the Biological Sciences, Moreholt, Brandwien, Joseph, (W. J. Gage Limited, 1500 Birchmount Road, Box 550, Scarborough, Ontario.)

Teaching Science in Today's Secondary Schools, Thurber and Collette, (Allyn and Bacon)

Teaching the Pursuit of Science, Woodburn and Obourn, (Macmillan)

The Teaching of Science as Inquiry, Schwab, (Harvard University Press, Cambridge, Mass.)

Teaching Science by Inquiry, Sund and Trowbridge, (Merrill)

Patterns for the Teaching of Science, Massey, (Macmillan Co. of Canada)

Teaching Science Through Discovery, Carin and Sund, (Merrill)

Science Experiences with Inexpensive Equipment, C. J. Lyne, (Van Nostrand Co., Ltd., 25 Hollinger Road, Toronto 16, Ontario.)

Science Model Making, R. R. Hopwood, (Longmans Canada Limited, 137 Bond Street, Toronto 2, Ontario.)

Science Experiences with Ten-Cent Store Equipment, C. J. Lyne, (Van Nostrand Co., 25 Hollinger Road, Toronto 16, Ontario.)

Classroom Aids for Teachers, (Department of Education)

GENERAL

History of Science Cases for High School, Klopfer, (Science Research Associates)

Illustrated Encyclopedia of Modern Sciences, (Thomas Allen Ltd., 266 King Street West, Toronto 2B, Ontario)

Introductory Physical Science, (Prentice-Hall Inc., Englewood Cliffs, New Jersey.)

On Understanding Science, Conant, (Yale University Press, New Haven, Conn.)

School Facilities for Science Instruction, Richardson, (National Science Teachers Assoc.)

Science and Ideas, Arons and Bork, (Prentice-Hall)

New Developments in Science Teaching, Lee, (Wadsworth Publishing Co., Inc., Belmont, California.)

Your Science Fair, Welte, Diamond and Friedl, (Burgess Publishing Co., 426 South 6th Street, Minneapolis 15, Minn.)

PERIODICALS

Physics Education, Institute of Physics and the Physics Society, 41 Belgrave Square, London W.C.1, England

Canadian Chemical Education, Chemical Institute of Canada, 151 Slater Street, Ottawa 4, Ontario

Endeavour, Imperial Chemical Industries Limited, Millbank, London, S.W.1

Journal of Chemical Education, 20th and Northampton Streets, Easton, Penn.

The Physics Teacher, 1201 - 16 Street N.E., Washington, D.C., U.S.A.

SCAT Bulletin, 11010 - 142 Street, Edmonton, Alberta (obtained free with membership in the Science Council, A.T.A.)

School Science and Mathematics, Central Association of Science and Mathematics Teachers Inc., P.O. Box 408, Oak Park, Illinois

The School Science Review, Association for Science Education, 52 Bateman Street, Cambridge, England

Science News, A & B Science News, Allyn and Bacon, Inc., 150 Tremont St., Boston 11, Massachusetts

Science News Letter, Science News, Inc., 1719 N. Hollinger Road, Toronto 16, Ontario

The Science Teacher, National Science Teachers Association, 1201 Sixteenth Street N.W., Washington 6, D.C.

Science World, 33 West 42nd Street, New York 36, New York

Scientific American, 415 Madison Avenue, New York 17, New York, U.S.A.

LIST OF SUPPLIERS

Canadian Laboratory Supplies

Central Scientific Co.

Stark Electronic Instruments Ltd.
Ajax, Ontario

Welch Scientific Co.

Audio Educational Aids
Dept. 53, Box 250
Butler, Missouri

Science Kit Inc.
2299 Military Road
Tonawanda, N.Y. 14150

Nasco, Science and Math.
Fort Atkinson
Wisconsin, 53538

American Science and Engineering Inc.
11 Carlton Street
Cambridge, Mass. 02142

Science Materials Center
59 Fourth Avenue
New York 3, New York

Science Service
1719 N. Street N.W.
Washington 6, D.C.

C.I.S.C.O., Calgary

LaPine Scientific Co.
6001 South Know Avenue
Chicago 29, Illinois

Ealing Corporation
2225 Massachusetts Avenue
Cambridge, Mass. 02140

Jewel Aquariums Co. Ltd.
5005 West Armitage Avenue
Chicago, Illinois 60639

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SENIOR HIGH SCHOOL CURRICULUM
GUIDE FOR SCIENCE --
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